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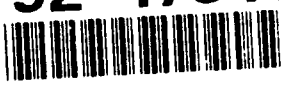

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RESHAPING TACTICAL AIRCRAFT DEVELOPMENT AND PROCUREMENT PRACTICES FOR THE NEW U.S. DEFENSE STRATEGY OF RECONSTITUTION

Prepared by

Todd A. Manning
Second Lieutenant, USAF

1992

Length: 51 pages

Degree: Master in Public Policy

Institution: John F. Kennedy School of Government,
Harvard University

EXECUTIVE SUMMARY

With the decline of the Soviet threat abroad and the prolonged recession and mounting budget deficits at home, the United States is in the process of slashing its defense budget to the smallest portion of its GNP since before World War II. Military planners have responded by formulating a new U.S. defense strategy. This new strategy relies upon the maintenance of a high-quality "base force" to react to more probable and immediate types of conflict, while relying upon the "reconstitution" of forces in the event of an impending major conflict. The defense industrial base, however, which must be preserved for the U.S. to be able to reconstitute a viable force, is in the process of being decimated by plummeting defense purchases and outmoded procurement policies.

Focusing on the airframe manufacturers of attack and fighter aircraft, this paper analyzes variations of three potential government policies for weapons development and production to determine which would best enhance the nation's ability to rapidly reconstitute a high-technology force should the need arise. The most viable of these policies are "graded" according to a list of "reconstitution criteria." This "grading" estimates how the various policies affect such things as industry responsiveness, total cost, probable political support, and the tradeoff between present and future military capacities.

The first potential policy analyzed is the presently favored "hands-off," or "free-market" approach to the restructuring of the defense industry, which is leading the major contractors to team together to bid on future projects. Other variations of this hands-off policy that are analyzed in this paper are the government encouragement of increased commercial diversification for defense firms, government support for additional weapons exports, and

government implementation of more weapons-upgrade programs in lieu of new program starts.

The second potential policy analyzed for its contribution to reconstitution is the more direct control of weapons development and production by the government. Options ranging from the government selection of the few "best" tactical airframe manufacturers to exclusively support, to the complete government nationalization of the tactical airframe industry are considered. A government/industry consortium for weapons development is also briefly discussed.

Finally, the plan that is gaining momentum with Washington policymakers--ongoing prototyping with occasional limited production of weapons systems--is analyzed. A variation of this plan best satisfies the reconstitution criteria by preserving a viable, high-technology aerospace defense base. Three additional qualifications need to be added to this endorsement, however, some of which are absent from the present debate in Washington.

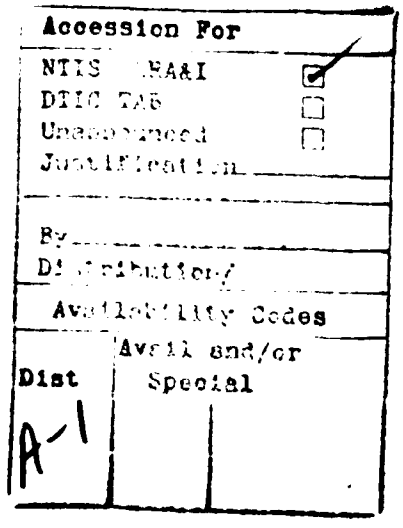
First, should this plan become the new paradigm for weapons development and production, additional funding and emphasis must be placed upon the evaluation of prototypes for their warfighting potential, not just their aerodynamic performance and handling qualities. Systems which have not proven their military utility will be of little value should the need arise for a rapid reconstitution.

Second, a commitment must be made to building a military of force-multiplying "silver bullets." The F-117 Stealth Fighter is an example of this type of system which, though procured in small numbers, altered the nature of battlefield operations in the Gulf War.

This type of commitment to limited production for the most successful prototypes provides industry the incentive to design

high-quality aircraft. Building such a force should also save the nation money by dramatically reducing the total numbers of weapons systems that have to be procured and supported. Additionally, such a plan should significantly strengthen the warfighting capacity of the military's small yet capable base force, by keeping in its hands weapons systems which are at least a generation ahead of those of any potential adversary.

Finally, to ease both the defense industry's and the military's transitions from massive procurement to continued prototyping with occasional limited production, upgrades to existing systems should be emphasized until new systems with significantly enhanced performance are developed.



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RESHAPING TACTICAL AIRCRAFT DEVELOPMENT AND PROCUREMENT PRACTICES FOR THE NEW U.S. DEFENSE STRATEGY OF RECONSTITUTION

Prepared for

Pat Garrity
The Center for National Security Studies (CNSS)
MS A112
Los Alamos National Laboratories
Los Alamos, NM 87545

by

Lt. Todd A. Manning, USAF
Candidate for Master in Public Policy Degree
John F. Kennedy School of Government
Harvard University

7 April 1992

Advisors

Charles Zraket
Peter Zimmerman
Dorothy Zinberg

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1.0 INTRODUCTION

The long-yearned-for end of the tense bipolar world of superpowers might harken a "New World Order" not of peace and goodwill, but instead, instability and unpredictability, as pent-up territorial, resource, ethnic, and religious conflicts may at last be unleashed. The proliferation of advanced weaponry throughout the Third World makes the situation even more perilous. One need look no further than the recent war in the Gulf to find evidence of the continued utility of military power in the post-cold war era.

Thus, Senator John McCain, the ranking minority member of the Senate Armed Services Committee, cautioned in his analysis, *Meeting the Challenges of the 1990s: The New Priorities for U.S. Strategy and Force Planning*, "[While] we do not live in a world at war, we [do] live in a world of wars."[1] Facing this new world of more diffuse, yet increasingly well-armed threats while constrained by shrinking defense budgets, American military planners have crafted a new national defense strategy--reconstitution.

2.0 RECONSTITUTION

This new post-cold war defense strategy prescribes maintaining a high-quality, ready "base force" for response to the more probable and immediate types of conflict, while relying upon a significant amount of warning time (of a few years) to "reconstitute" its forces in the event of an impending major conflict. The Joint Chiefs of Staff called this plan for reconstitution "the linchpin of America's long-term security."[2] It does seem ingenious--reconstitution allows for resources to be diverted from defense in the short run while military tensions are eased, yet provides a form of insurance for the future should any potentially significant threat reemerge. Reconstitution might even work as an inexpensive, unthreatening form of deterrence, "casting a long shadow forward" which might dissuade a potential adversary from breaking a treaty or embarking on another arms race some time in the future.[3]

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1 McCain, Science and International Security, p. 8.
2 "Our Best Chance of Peace," Air Force Magazine (AF Mag), p. 6.
3 Wagner and Gold, Science and International Security, p. 56.

For such a strategy to be effective, however, it must be believable that the U.S. would prevail in a competitive reconstitution. Setting aside the question as to whether or not it is possible for a democracy such as the U.S. to recognize a threat and mobilize in a timely fashion (no small assumption), for the U.S. to prevail in a competitive reconstitution, it must have a superior defense industrial base from which to build. As Secretary of Defense Richard (Dick) Cheney stated, "[Reconstitution] allows us to reduce our forces now, ***so long as we are prepared to build . . . 'wholly new forces' should the need to counter a global threat reemerge.***"[4] (Emphasis Added). According to several sources, however, this strategy was arrived upon ". . . before any real industrial planning for [it] had been done."[5] Indeed, "the United States seems destined to enter the future with a strategy that counts on the capability to reconstitute forces but with a defense industrial base that is declining on all fronts."[6] There appears to be a dangerous hole in the strategy.

3.0 DEFENSE INDUSTRY DECLINE

To make this analysis more concrete, this paper will focus upon the production of high-technology attack and fighter aircraft. This class of weapon system was chosen because of the importance of U.S. tactical airpower in countering proliferated threats worldwide, the critical importance of high-technology to tactical air warfare, and the severe budgetary trough the aerospace industry is about to enter.

3.1 Plummeting Defense Budget

With the disintegration of the Soviet Union, and with it, the threat that it posed to freedom and democracy around the world, the American defense establishment is in the process of being whittled down by at least 25 percent in both manpower and equipment. Despite this sizable cutback, a number of Congressmen and presidential candidates want to cut the defense budget

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4 Lifeline Adrift, p. 4.
5 Correll and Nash, "Industrial Base Policy Adrift," AF Mag, p.42.
6 Correll and Nash, "The Industrial Base at War," AF Mag, p. 56.

significantly further. Even some former secretaries of defense are advocating a 50 percent cut in this budget.[7]

The present cutbacks have already been devastating to the defense industry. Since 1986, the real level of procurement expenditures by the Pentagon has dropped by 50 percent.[8] The aerospace industry was especially hard hit and it continues to be battered. Between 1990-93, the Pentagon's budget authority devoted to aviation will drop another 23 percent;[9] the number of developmental aircraft projects will drop from the 25 in fiscal year 1992 down to 6 within five years.[10]

In the past year the Navy has been forced to cancel its F-14 upgrade program, its proposed spin-off of the Air Force's upcoming advanced tactical fighter (ATF), and its first attempt at developing the A-12, a new medium-range, stealth attack jet. When cancellations of its non-attack aircraft developmental programs are included, the Navy has been forced to cancel over $7 billion in aircraft developmental programs within the past two years.[11]

This cancellation of new programs is forcing older aircraft to remain operational longer before replacement. The Navy's primary medium-range attack jet, the A-6 Intruder, for instance, which was supposed to be replaced by the A-12, was designed in the 1950's and used in Vietnam. Deputy Secretary of Defense Donald Atwood recently announced that its follow-on system, the AX, should not be operational until 2010. By then, America will be relying upon a naval attack aircraft designed nearly 60 years earlier! Combining these program cancellations and operating extensions with the fact that there is presently a greater need for weapons systems to be retired than replaced (due to the dramatic downsizing of the military), and one can begin to understand the dire straits many tactical airframe manufacturers are finding themselves in--the industry is simply not getting enough business to stay alive.

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7 Lerner, Aerospace America, p. 26.
8 United States, Congress, OTA, Redesigning Defense, p. 4.
9 Ibid., p. 3.
10 Aspin, Report on "Tomorrow's Defense," p. 4.
11 Scott, "Funding Issues to Dictate Future of Navy's Forces and Purchases," Aviation Week & Space Technology (AW&ST), p. 54.

Between 1993 and 1997, for instance, there will be a five-year gap in which ZERO fighter or attack aircraft will be produced for the United States Air Force.[12] It is difficult to preserve and improve any industry for the future by cutting off its lifeblood of profits and production, not to mention the danger inherent in having no open production line of fighters should the need arise to surge production.

3.2 Outmoded Procurement Policies

Unfortunately, America's system for procuring tactical aircraft which worked so well throughout the cold war will, if stubbornly adhered to, cripple America's ability to reconstitute its tactical air forces should the need arise. During the cold war, "U.S. policy insisted on continually having major weapons production programs in place and follow-on systems in the works," stated Sean O'Keefe, the Pentagon's comptroller.[13] This kept money flowing into these fighter aircraft developers which, in turn, kept competing engineering design teams alive and production capacity utilized.

Around the dawn of the next century, however, following the five-year hiatus from having *any* tactical aircraft produced, the Air Force will begin operating the ATF, its lone air supremacy fighter for the next three decades. Obviously, with so few contracts upcoming, winning a contract such as this is literally do-or-die for many of the present attack and fighter airframe producers. In fact, many competitors viewed this contract "the key to surviving into the next century."[14] Winning this type of contract not only provides long-term profits and keeps productive capacity utilized, but it also provides the winners of the contract the opportunity to develop and work on state-of-the art technologies that will be the key to winning later contracts. Thus, the losing contractors lose out not only in profits and production, but also in future competitive capacity.

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12 Lifeline Adrift, p. 4.
13 Schoenfeld, "Major Overhaul of Defense Industrial Base on the Way," New Technology Week, p. 11.
14 Morrocco, AW&ST, p. 65.

While the ATF will almost certainly be more technologically advanced than any aircraft a potential enemy could develop for a decade or more, it is doubtful that it will remain the technologically superior aircraft for over three decades. This is especially true when one considers that with the current acquisition process, it takes nearly 20 years to move such a major weapon system from R&D to full deployment. Thus, the ATF which went into development in the early 1980's undoubtedly had certain technologies frozen in that timeframe, making parts of the ATF obsolete before the aircraft even becomes operational.

Additionally, while the 30-year production of the ATF will maintain funding to the production end of a limited number of aircraft developers, the research and development side of the industry could slowly wither away. The present drawn-out procurement paradigm will have to change or a number of aerospace firms will go out of business. Those remaining will have emaciated development teams. With the aerospace industry in such disrepair and a technologically antiquated tactical air force, America could find its security in serious danger should a potential enemy drive it to attempt to rapidly reconstitute its forces.

3.3 Impact on Airframe Manufacturers

Presently, there are seven major tactical airframe manufacturers (General Dynamics, McDonnell Douglas, Northrop, Lockheed, Boeing, Grumman, and Rockwell International). The challenge ahead is to develop a smaller, yet still versatile and competitive industry which can, despite the austere budgetary environment, maintain its technological edge, knowledge base, and its capacity to respond quickly if it becomes militarily necessary.[15] Secretary of Defense Richard Cheney stated, "There is no question some firms are going to go out of business in the aerospace industry."[16] Malcolm Currie, the chairman and CEO of Hughes Aircraft further elaborated that this industry is only at the tip of the iceberg when it comes to downsizing, mergers, and

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15 Ibid., p. 62.
16 Correll and Nash, "Industrial Base Policy Adrift," p. 42.

firms going out of business.[17] While some of the larger prime contractors will be able to weather this storm, many small contractors--a vital but oft-neglected portion of the aerospace industry--will not.

With no tactical aircraft production for the Air Force between 1993 and 1997, firms will almost undoubtedly have to shut down their plants and lay off many of their skilled workers. Talented engineers will also be either laid off or reassigned to non-tactical aircraft projects. This diversion should not be brushed aside lightly. A 1990 study done by the Defense Science Board, determined that the most difficult resource to replace in the aircraft development process was neither materials nor plant tooling, but the skilled design teams.[18] The 1991 OTA report entitled *Redesigning Defense* echoed this, finding that "Across the board, managers at laboratories, private firms and within DoD identify human resources as the key to the nation's defense R&D capability."[19]

Industry's problems are further exacerbated by the adversarial relationship between industry and government. Again, according to Malcolm Currie of Hughes Aircraft, "A 'business-as usual' will fail [unless] both government and industry must make fundamental changes in the way they do business."[20] Industry complains that the government auditors, fixed-price contracts, and emphasis on cost over quality in design, make it difficult for any of the contractors to be successful. Complained the CEO of Loral, "I cannot hire auditors and lawyers fast enough, [but] am forced to lay off scientists and engineers."[21] Furthermore, Congress seems to vary its intended purchases of military aircraft monthly, not to mention the fact that it allows lower profit margins for the defense contractors' work than could be made investing in government bonds.[22] Executives from one of the "better managed" defense firms called the defense industry a "Gambler's Paradise"

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17 Lifeline Adrift, p. 3.
18 Comment from Charles Zraket, member of that DSB panel.
19 United States, OTA, Redesigning Defense, pg. 92.
20 Morrocco, AW&ST, p. 62.
21 Berry, AF Mag, p. 65.
22 Lifeline Adrift, p. 45.

because US defense priorities are so vague and ill-defined that industry has to make educated guesses as to where to invest hundreds of millions of dollars in R&D.[23]

The government, on the other hand, complains that it has to audit industry or succumb to further $500-hammer scandals which wreck the military's reputation (and with it, its share of future budget allocations). Additionally, companies often make extremely low estimates of how much it will cost them to develop a new system in an attempt to win the development contract for it. Later, once a company is the sole producer for a system, it uses its exclusive position to gouge the government in the production contract.

While the nation can probably weather such disputes, and with them, the ever-weakening defense industry in peacetime, there is less assurance that industry will be able to respond adequately in wartime. And "if it cannot, the nation will have deceived itself with a defense industrial base that . . . [when] the shooting starts [will] flunk the test that really matters."[24]

4.0 INCREASED IMPORTANCE OF MILITARY R&D

With a declining threat and diminishing forces, it is critical that the nation remain committed to defense R&D. As Alan Bromley, the President's Science Advisor, noted in his report entitled, *The U.S. Technology Policy*, defense R&D is important to ". . . provide options for future weapons systems development and to help avoid technological surprises by potential adversaries."[25] In addition to keeping America abreast of the utility of technological advances made by potential adversaries, there are at least three other reasons for America to concentrate its defense resources on research and development.

First, Americans are unlikely to support a war of attrition. Congressman Les Aspin, the chairman of the House Armed Services Committee, stated, "[The] public will back the use of force, in

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23 Velocci, "Ill-Defined U.S. Defense Priorities," AW&ST, p. 141.
24 Lifeline Adrift, p. 8.
25 Bromley, p. 5.

U.S. interests, if the war is fast and low in casualties. High-tech weaponry [achieves] those goals."[26]

Second, high technology is America's comparative advantage. Throughout the cold war, qualitative advantage was favored over quantitative. In light of the shrinking military, no one is promoting a reversal of this policy which served the nation well for the past 45 years.

Finally, investments in R&D save this nation money in the long run. An additional emphasis has been placed upon reliability and maintainability in newer, high-technology systems which directly translates into fewer parts and people, and lesser maintenance time and cost. It also allows a particular weapon system to strike repeatedly, reducing the overall quantity of this type of weapon system that has to be procured.

Military R&D also led to the innovation of high-tech, yet money-saving stealth technology. American F-117 stealth fighters proved in the Gulf War that unlike traditional attack aircraft, F-117's did not need tactical jammers and fighters as escorts on air strikes. With its precision laser-guided munitions, the F-117 proved that it could destroy on one solo pass what might previously have taken several passes by "force packages" of older-generation aircraft. Its invisible penetration and one-pass effectiveness against hardened targets not only reduced the number of pilots lives which had to be placed in danger, but it also reduced the total number of F-117's which needed to be procured to make an effective force. Additionally, such a breakthrough dramatically reduces the total number of other types of aircraft which need to be procured (in essence, also slashing the maintenance, training, and operating expenses of these additional aircraft which are no longer required).

Air transport costs and resources can also be reduced by high-technology systems. While it takes 17 C-141's (large, Air Force cargo jets) to transport the support for a squadron of F-15's to a

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26 Toth, Los Angeles Times, p. A13.

distant location, it will take less than half that number to transport the support for a squadron of ATF's.[27]

Thus, high-technology weapons systems can speed a war's conclusion, limit casualties, increase a system's reliability and maintainability, and reduce the total number of systems which need to be procured and personnel which need to be employed (without reducing the overall force's effectiveness). With declining defense budgets and a defense strategy based upon reconstitution, it is critical that America adopts a policy which will allow it to maintain high-technology forces.

5.0 GOVERNMENT POLICY OPTIONS TO MEET THE NEEDS OF RECONSTITUTION: HIGH-TECH WEAPONRY AND A RESPONSIVE DEFENSE BASE

In this section, variations of three potential government policies--"hands off," direct control, and prototyping with limited production--will be analyzed to see which would best assure high-technology weaponry and a responsive aerospace defense base. The most promising proposals are graded by the following "Reconstitution Criteria":

1) The tradeoff between maintaining present military operating capacity and providing for future military potential, and the associated short and long run impacts on the level of military technology to be acquired

2) Probable design diversity (likely number and quality of competing designs)

3) Impact on prime and sub contractors

4) Industry responsiveness for reconstitution

5) Cost

6) Probable political support

7) Alterations necessary to procurement bureaucracy

5.10 Present Hands-off Policy

The present Administration mistakenly believes that its hands-off policy is really a commitment to free market principles. As a

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27 McDonald, AF Magazine, p. 56.

recent article in *Aviation Week & Space Technology* put it, "Dogmatic about free-market ideology, the White House has eschewed even a common-sense national industrial policy. And so the Pentagon watches from the sidelines as U.S. defense companies struggle to stay afloat."[28] Ralph Hawes, a former executive vice president of General Dynamics, stated it more aptly, pointing out that while the national policy is "Let the free market rule, defense business does not operate in a free market. It is a monopsony situation, with a single buyer that makes the rules, not a free market situation at all."[29] The government issues a Request for Proposal (RFP) for all of its proposed weapon development programs which dictates exactly what qualities the proposed weapon system must have. It then establishes acceptable profit margins for the company, and mandates exactly to whom this weapon system can be sold. Of course, the government always reserves the right to immediately stretch-out or cease production, regardless of the terms of the contract. Such an arrangement is hardly a free market.

The turbulence and uncertainty associated with this hands-off policy decreases the contractors' willingness to invest in military technologies, thereby speeding the shrinkage of the defense industry.[30] The CEO of Hughes Aircraft stated, ". . . a smaller industry is inevitable and okay, ***as long as*** it is technically and competitively vital and profitable."[31] (Emphasis added).

The question one might be asking, then, is how many of the present seven attack and fighter airframe manufacturers need to survive for this industry to remain both technically and competitively vital and profitable? Presently, each of the tactical airframe manufacturers is insisting that it will survive by capturing a bigger slice of the shrinking pie.[32] Obviously, this is impossible--with the defense budget plummeting, firms are going to have to merge or go out of business. According to a

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28 "Soviet Conversion is No Panacea," AW&ST, p. 7.
29 Berry, AF Mag, p. 65.
30 Gilmartin, AW&ST, p. 68.
31 Berry, AF Mag, p. 65.
32 Rosenbaum, New York Times, p. 17.

recent article in the *New York Times*, "Most analysts believe that by the end of the decade, two or three [airframe manufacturers], ***at most*** will remain."[33] (Emphasis added). This leaves the nation faced with the question of whether it will tolerate having its present broad base of seven tactical airframe manufacturers pared back to such a narrow few. The potential for a rapid reconstitution would certainly not be enhanced by such a diminished base.

Some might suggest that this is too strong a conclusion to be drawn. After all, there has been an excess aircraft production capacity for years in the United States, so to a degree, downsizing could make the industry more efficient. The danger comes from downsizing in such a way that the industry becomes less competitive in terms of technological advancement and pricing and in its ability to provide diverse designs. Another danger is that the airframe industry will downsize such that it loses its capacity for rapid production should reconstitution become necessary. Extending the current prototyping paradigm in which, for instance, the Navy gets a new medium-range attack jet every 60 years (A-6 to AX) seems likely to lead to exactly the type of inefficient downsizing the nation would like to avoid.

In this paper, I do not try to answer the question as to how many tactical airframe manufacturers should survive. The answer is probably less than the present seven, but more than one. The real puzzle is designing a new weapons development paradigm which will allow the present production overcapacity in the industry to contract, but that will at the same time maintain or enhance the industry's technological and price competitiveness, design diversity, and reconstitution production capacity.

5.11 Industrial Teaming as a Response to Hands-off Policies

With defense dollars decreasing and present policymakers seemingly committed to following a hands-off policy toward the defense industrial base, contractors are turning to teaming (cooperatively designing and bidding on weapon systems) to help them survive into the next century. One need look no further than

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33 Ibid., p. 17.

the nation's most recently initiated attack aircraft development project, the Navy's AX, to find a good example of this trend toward industry teaming. (In actuality, this is the Navy's second attempt to initiate this project, the last one canceled last January due to cost overruns and coverups.)

Because the AX program is one of only a few major prizes left for tactical airframe manufacturers, many (if not most) of these contractors see winning the contract for this aircraft to be crucial to their future prosperity. Indeed, this program ". . . could make or break some major companies in the [coming] financial and structural upheaval in the aerospace industry."[34] In fact, "Without the AX, some companies are going to drop out of the military-airframe business. . . as the losers forfeit billions of dollars in revenues and a competitive edge" in the design and production of leading technologies.

All of the leading manufacturers of military airframes would probably rather "go it alone," states the chairman of the defense firm LTV, but the [current] environment does not allow it.[35] Five "inter-woven" teams formed for initial concept exploration for the AX have recently been awarded $20 million contracts by the Navy. These inter-woven teams are (in no particular order): 1) Rockwell International and Lockheed, 2) Northrop, General Dynamics, and McDonnell Douglas, 3) Lockheed, General Dynamics, and Boeing, 4) McDonnell Douglas and LTV, and 5) Grumman, Boeing, and Lockheed.

This teaming, however, as *Aviation Week & Space Technology* points out, is a "double-edged sword."[36] On the positive side, it reduces a company's risk by the sharing of the financial burden of making a bid on the program. Furthermore, the more creative minds that are competing to solve a problem, the greater the likelihood that a high-quality, affordable solution will be found. Additionally, in many cases, the teamings are mutually beneficial. For instance, General Dynamics and McDonnell Douglas lost the

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34 Velocci, "AX Competition Critical to Many Team Members," AW&ST, p. 18.
35 Schoenfeld, "Teaming Becomes a High-Tech Enterprise in Defense World," New Technology Week, p. 10.
36 "Don't Muddy the AX Waters Again," AW&ST, p. 7.

previous developmental contract they held for the AX (then the A-12) due largely to cost overruns and the expected inadequate performance of the aircraft. The contractors claimed that these problems were the result of the government not providing them access to information as to how the stealth components for the B-2 Stealth Bomber were manufactured. Most of this information, however, was the proprietary information of Northrop, so McDonnell Douglas and General Dynamics were denied access. In the new teamings, however, the three are united so that they can share in their areas of comparative advantage. Such symbiotic teamings should undoubtedly improve the final result of the AX competition, both in terms of cost and quality. One final advantage of the teamings is that at least in the short run, it preserves funding to more of the contractors, which in turn provides for a broader defense base should the call come for reconstitution.

On the other hand, splitting the funds allotted for concept exploration among five teams (composed of at least two contractors per team) has the danger of spreading the resources so thin that none of the teams can do nearly as solid a job as any of the individual contractors could have if they had instead been given a larger portion of the concept exploration funds for themselves. Due to the magnitude of the contract, however, the competing firms are likely to invest massive amounts of their own corporate funds into the project, with the net result being a weakened surviving industrial base. With the winners having so heavily invested internal funds into the project, the financial reward of winning the contract will be diluted; the losers' investments in this project are likely to speed their exit from the industry.

Aviation Week & Space Technology justifiably questions whether the "lottery-type approach [will] diminish rather than enhance a company's chances of being on the winning team."[37] One might also question the safeguards on the possibility of unwitting technology transfer between firms. The chairmen of all of the various companies assure that such a transfer absolutely could not happen, but with the stakes so high, this deserves a deeper inspection.

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37 Ibid., p. 7.

Without trying to cast shadows on any firm in particular, Lockheed, for example, is a member of three different teams, two as a subcontractor and one as a prime. With so much at stake, it does not seem beyond the realm of the possible that secrets learned from other companies in the "sub-teams" could be passed on to the prime team. If, on the other hand, as the CEOs vigorously assert, the barriers against technology transfer are inviolate, what does it say for efficiency in this era of declining defense dollars for two different McDonnell Douglas design teams, for example, to be forced to do duplicate design work without any exchange of data?

At least in the eyes of General Dynamics chairman William Anders, "Teaming has [only served to] distort the market and inhibit economic restructuring" in the industry.[38] Rather than having strong companies merge, the AX could be a competition in which the contractors from the winning team "take it all," while the contractors from the losing teams go out of business. This is a dangerous method for diminishing industry overcapacity and would not bode well for reconstitution 15 years hence.

Grading Teaming by the Reconstitution Criteria

1) Present military capacity vs. future military potential

In the short run, a superior aircraft is likely to result from teaming. The massive investment of corporate funds, however, is likely to weaken the winning firms and hasten the exit of the losing firms from the industry. This is not the optimal way to reduce overcapacity in the airframe industry, and could weaken the nation's future military potential.

2) Probable design diversity

There will be at least five designs for the AX, but perhaps only the partners on the winning team for this program will survive to bid on the follow-on.

3 Impact on prime and sub contractors

The number of primes is likely to shrink, and the subcontractor base will likely follow this trend.

4) Industry responsiveness for reconstitution

In the short run, seven airframe manufacturers survive which could probably be tooled to rush almost any tactical aircraft into production. Over the longer run, this base is likely to be whittled down dramatically.

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38 "GD Chairman Says Market Distorted," AF Mag, p. 19.

5) Cost

Assuming Congress sticks with its plans to produce this aircraft, a higher-quality, lower cost AX will undoubtedly result than the last go-around with this program. Future development costs could be higher, however, depending upon the amount of competition which will exist in the future's shrunken industry.

6) Probable political support

Politicians seem to prefer the status quo and this plan requires few changes from the cold war procurement paradigm. Furthermore, this policy fits ideologically with the Administration's commitment to the free market.

7) Alterations necessary to procurement bureaucracy

None, other than the additional initial contracts for concept exploration.

5.12 Government Encouragement of Industry Diversification into Commercial Markets

This is another way for the government to remain "hands-off," while still trying to mitigate the adverse effects of diminished government funding to the defense base. Pentagon comptroller Sean O'Keefe already signaled that this was official policy by issuing the decree, "Defense firms must become competitive in commercial markets."[39] According to the professional journal of the aerospace industry, "much of [defense] aerospace can be converted to civilian application."[40] Indeed, it warns, hundreds of thousands of jobs are likely to be lost in this industry unless there is a massive conversion of resources to the civilian sector. According to a recent *US News and World Report* article, many defense contractors are viewing this as a historic opportunity to diversify from solely military production.[41]

It is worth cautioning, however, that converting weapons plants to civilian plants is rarely successful. As Norman Augustine, the chief executive of Martin Marietta stated, "When it comes to diversifying, the defense industry's record is unblemished by success."[42] Unfortunately for the defense firms, most of them have limited experience working in the civilian sector, as even companies like Boeing with its vast commercial expertise find it in

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39 Schoenfeld, "Major Overhaul of Defense. . .", p. 11.
40 Lerner, Aerospace America, p. 26.
41 Auster, p. 42.
42 Rosenbaum, New York Times, p. 17.

their best interest to keep their military and civilian divisions separate.

In an attempt to diversify after Vietnam, the military division of Boeing attempted to produce trolley cars, while Grumman tried to make busses--and both were admittedly "embarrassing and costly" mistakes.[43] Because of these companies' histories of doing defense work, their products were overdesigned and so high in production and operating costs that the companies ceased doing business outside of the sheltered environment of the Pentagon. In a study of other defense firms' attempts to diversify into commercial markets in that era, 8 out of 10 were utter flops.[44] The successful ones were those that bid for other government contracts with similar procurement processes, accounting requirements, and marketing protocols as the Pentagon.

Recent attempts by defense firms to diversify have been a bit more successful. One study found that half of the defense firms which decided to offer a commercial product in the past 5 years succeeded.[45] The catch here was that often these firms "diversified" by simply acquiring outside companies which already produced commercial products with a proven track record.

It seems the lesson to be learned is that while some companies, such as Hughes Aircraft, are finding it in their interest to aggressively pursue commercial markets, others, such as General Dynamics are choosing to shed themselves of commercial diversions to focus upon defense products. Thus, the *New York Times* is on track in stating that on the whole, the defense industry would only ". . . be further damaged by new regulations to emphasize commercial technology."[46] For this reason, I will not grade diversification according to the "reconstitution criteria."

5.13 Government Encouragement of Defense Exports

Defense contractors have a number of reasons to like exports. First, additional output lowers unit costs--and lower unit costs

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43 Pearlstein, Washington Post, p. A18.
44 Ibid, p. A18.
45 "Tread Carefully with Commercialization," AW&ST, p. 7.
46 Rosenbaum, p. 17.

usually translate into greater domestic political support for purchases. Exports also provide defense firms with additional revenue--in many cases the profit margin on exports is twice that within the US, and the additional revenues from providing training and spare parts can often double or triple the total value of the contract.[47] Overseas sales also can help to keep an experienced workforce intact and help bridge the gap to new programs.[48]

Besides providing additional funding to the domestic defense industries, the government has additional reasons to like exports. First, they help in the balance of trade. Second, the Commerce Department estimates that every $1 billion in defense exports keeps 19,000 people at work in the U.S.[49] Additionally, exports can help to maintain peace by contributing to the establishment of a regional power balance (although America's record with this is somewhat dubious). Exports can also help to keep domestic product lines open, which would be of great help should the need arise for reconstitution. The Saudis, for instance, would like to purchase 72 F-15 fighters for over $4 billion. If the Congress approves of such a sale, it will enable the F-15 plant, scheduled for an impending shutdown, to remain open for two more years.[50]

Exports, however, depend on not only upon Executive approval, but also Congressional approval due to the complex diplomatic, social, and ethical issues which often transcend simple business considerations and defense base concerns. After all, the Congress does "not want to be responsible for the arming of future Saddams," as Senator Tom Harkin, former Democratic candidate for president, stated in a recent address at the JFK School of Government.[51] On the other hand, if the U.S. does not export its arms, other nations will, and while Arabs prefer U.S. arms, they will take their business elsewhere. The former Soviet Union, for example, is exporting its most advanced fighters to such nations as Syria and Iran in exchange for hard currency.

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47 Velocci, "Middle East Offers U.S. Firms an Aerospace Sales Bonanza," AW&ST, p. 55.
48 "Support Sensible Foreign Military Sales," AW&ST, p. 9.
49 Fulghum, AW&ST, p. 20.
50 Oliveri, AF Mag, p. 17.
51 Harkin speech, 23 Jan 1992.

As if the issue were not already complicated enough, the Congress also has to consider technology transfer concerns. Presently, stealth technologies are not even exported to America's European allies, much less to the Third World. As technology advances, this trend is likely to increase, which could be ". . . devastating for U.S. aerospace firms over the long term," according to *Aviation Week & Space Technology*.[52] For exports to continue, the US will have to find ways to export different versions of its weaponry, perhaps with lesser stealth coatings. Otherwise, the Europeans with their new EFA and the French with their new Raphale fighter, both of which cost nearly as much as the American ATF despite being at least a generation behind in technology, will "laugh all the way to the bank" as they capture the entire world export market.

Although the present cutbacks in defense purchases are making foreign sales increasingly important, as of yet neither President Bush nor the DoD has issued any guidelines for U.S. defense contractors as to what the future holds.[53] While at least in the short run, loosened restrictions on exports would clearly augment the US policy of reconstitution, the issue of exports is far too complex to analyze through only this lens. Thus, exports will also not be analyzed by the reconstitution criteria.

5.14 Government Encouragement of Weapons Systems Upgrades

The fiscal year 1992 defense budget was $291 billion; by 2001, that budget is targeted to be cut to $244 billion. A recent study carried out by the Brookings Institute, however, suggests that this 2001 budget can be cut to $169 billion while still maintaining U.S. superiority, by stopping ***all*** new aircraft weapons production and instead concentrating upon life-extending upgrades.[54]

Even without grasping such a radical turnaround, defense contractors themselves are "embracing upgrades to survive in the 90's."[55] The manufacturers realize there are billions to be made

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52 "'Stealthy' Exports," p. 7.
53 Velocci, "Ill-Defined U.S. Defense Priorities. . .", p. 141.
54 Mann, AW&ST, p. 26.
55 Scott, "Manufacturers Embrace Upgrades to Survive in '90s," AW&ST, p. 42.

from aircraft upgrades, as governments look to give their older weapons systems new capabilities, reliability improvements, and decreasing support costs, not to mention an extended life. This is not just a domestic trend--in fact, the domestic market pales in comparison with the potential overseas market for aircraft upgrades. In nations such as Taiwan and Singapore, for instance, there are over 1800 Northrop F-5's which are prime candidates for upgrading.

Overall, however, this push toward upgrades will probably damage the tactical airframe manufacturing industry more than help it. Other than the life-extending re-winging of certain aircraft, most upgrades will be to the internal electronics or external payloads of aircraft, neither of which provides business to the airframe manufacturers.

However, while in the previous section I discussed how revolutionary stealth technologies might damage industry by limiting exports, such revolutionary technologies assist the airframe manufacturers in that stealth upgrades are difficult and expensive to accomplish. The radical shapes of the F-117 stealth fighter and the B-2 stealth bomber are evidence that stealth technologies need to be designed-into an aircraft, not added-onto an existing one.

A reliance solely upon upgrades, therefore, would both doom the reconstitution capacity of the present airframe manufacturing industry, and doom the future potential of the U.S. armed forces by forcing them to operate non-stealthy platforms. This would not be in the best interest of the nation.

5.15 Brief Summary of Hands-off Policies

The Administration's hands-off management of the defense industry drawdown is causing manufacturers to team, which is preserving more firms in the short run, but could exacerbate problems in the longer run. The Administration is also encouraging commercial diversification for the defense industries, but this is clearly not in each firm's self-interest. While increased exports could help preserve the industry in the short-run and provide the industry funds which could be reinvested in its future, Congress is

reluctant to authorize any massive arms export deals because of legitimate concerns of proliferation. While upgrades of attack and fighter aircraft would undoubtedly save the government money in the short run, exclusive reliance upon upgrades would save the nation money only at the larger expense of strangling the airframe industry. In sum, these hands-off policies seem to uniformly contribute to the dismantling of the defense industry and the repudiation of the intended defense strategy of reconstitution.

5.20 More Direct Government Control of Weapons Development and Production

Recognizing the potential adverse effects of the present hands-off policies, other alternatives must be explored. Three such proposals which involve more direct government intervention are discussed in this section.

5.21 Initiation of a Government/Industry Consortium for Weapons Development and Production

Recognizing the existing government/industry interdependence in weapons development, one policy to be considered is the establishment of a government/industry consortium (of the nature of the DoD- and industry-funded Sematech consortium) for joint development of weapons systems. In reality, however, this is already how the weapons procurement process works--government and industry already have an arrangement in which they work together to develop new weapons systems.

Government laboratories perform certain high-risk, high-reward type of research, the results of which are continually shared with industry. An example of this is the ongoing study in the Wright Patterson laboratories to derive a "smart skin" and "smart structure" for future combat aircraft, which would "sense strains and stresses on the aircraft and flex in response."[56] Such a discovery would allow for a much lighter aircraft, as many of the structural safety margins built into today's aircraft could be eliminated. The government also tests a number of tactical aircraft technologies (such as vectored-thrust nozzles) in flight

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56 Grossman, AF Mag, p. 30.

out at Edwards Air Force Base, both to determine the military applicability of such technologies and to provide relevant findings to industry.

In addition, the government establishes precisely which qualities it will demand in a weapon system such as a fighter aircraft and specifies them (cruise requirements, penetration and escape airspeeds and altitudes, weapons payload, etc.) in a request for proposal sent out to a number of defense contractors. It also monitors the industry's contract compliance. When it comes to actual aircraft design and production, however, the government leaves this task to industry.

5.22 Government Takeover (Nationalization) of All Airframe Development and Production Responsibilities

Because fewer aerospace firms will be around in the future to compete in the designing and pricing of next-generation aircraft, some might suggest that the government should simply take over this tasking and design and build its own airplanes. After all, under the arsenal system, the U.S. government designed and built its own weapons prior to the Second World War. And if the U.S. military already does much of the next-generation research, already sets the requirements for new aircraft, already monitors contract compliance, and already tests and operates the aircraft, why should it not in this era of defense budgetary cutbacks also design and produce its own aircraft?

This section considers the potential policy option of having the United States return to the arsenal system for aircraft development. Policymakers could choose to nationalize the tactical airframe manufacturing industry and hire back many of the industry experts as civil servants. Some additional benefits of such a plan would be that the government would no longer have to fund the oversight of industrial contracts, nor would it fund the overlapping engineering efforts of competing defense firms as it does today. Inefficient overcapacity in the industry could easily be done away with.

As attractive as this may sound, there are a number of reasons why it might not be such a wise idea. First, the present division

of tasks between government and industry maximizes the comparative advantage of the two institutions. The government can afford to invest in higher risk, longer-term research than industry, and should be the one specifying the desired characteristics of a next-generation fighter, since it is ultimately responsible for the nation's security. Industry, on the other hand, should be using its experience in designing and manufacturing to produce high quality, highly reliable, and low cost aircraft (though the government should, perhaps, provide more R&D funding for manufacturing and process technology).[57]

Second, since preserving design teams was found to be the most critical step which could be taken to preserve the nation's ability to rapidly reconstitute a technologically-advanced force (see Section 3.3), a government takeover of this industry which would inevitably scatter these design teams could not be in the nation's best interest. Nationalizing an industry in also not consistent with the American belief in and commitment to capitalism.

Third, the defense industry has been criticized for not keeping itself up to date with state-of-the-art commercial technologies. Government-run aircraft development and production would likely be even further removed from commercial technologies, as workers are stripped from their parent companies to become civil servants.

Finally, having the government take over and efficiently run any business would be challenging--having it take over the design and production of some of the world's most advanced technologies, with absolutely no experience, would be foolhardy. There are not many instances in which a government has taken over an industry and produced higher-quality output at lower prices--and the aerospace industry is too critical a sector to this nation's national security to risk such an experiment.

For the reasons mentioned, this nationalization option is likely to get zero political support. Therefore, it also will not be analyzed by the reconstitution criteria. The next option will be, however.

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57 Suggestion by my advisor, Charles Zraket, on my initial draft.

5.23 Government Chooses and Exclusively Supports the Few "Best" Defense Contractors To Survive

The Congressional Office of Technology Assessment (the OTA), in a recent report on restructuring the defense industry stated, "To keep R&D healthy and production mobilizable," the U.S. must identify and maintain "the critical facilities, technological know-how, and people needed to develop future systems and to provide a core for regenerating in a timely manner [should it become necessary]."[58] Some might take this as a recommendation for the government to select a few strong defense industrial firms now to keep viable through the impending downturn in defense expenditures. Another variation of this would be the development and production of tactical aircraft through weapons laboratories and GOCO (government-owned, contractor-operated) organizations, the method the government has used successfully for procuring nuclear weapons since the dawn of the atomic age some 47 years ago.

The first real problem with this option would come in the transition to it. If the government did commit itself to implementing this plan, it seems likely that the seven tactical airframe manufacturers would try desperately to become one of the three or four "best" contractors chosen to survive. The problem is, there is no rational means for determining which companies should be chosen--should the companies with the highest levels of technology be selected to survive, or those with the most experience, or those with the best history of cost control, etc., be selected? Assuming that one of these factors were to be selected as the primary criterion for choosing the "winning firms," how would one measure, say, a company's "level of technology?"

Secondly, there is no fair way to determine which companies should survive--would members of Congress be expected to accept the recommendations from a supposed nonpartisan commission as to which defense contractors "most deserved" to survive, or would they insist on making such a momentus decision for themselves? Congressional voting on such an issue would be both unwise and unfair--as with the closing of domestic military bases, politicians

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58 Bond, AW&ST, p. 65.

could not be expected to vote for the closing of a major industry within their own districts, even if it were in the "best interest" of the nation. The net result would likely be deadlock, the "capture" of the entire defense industry by the most populous regions (without regard to merit), or the haphazard bartering of valuable defense firms' futures as chips in some grand political bargain.

Could such a system be implemented, a danger of reduced competitiveness both in the designing and the pricing of aircraft would remain. After all, with a guaranteed profit stream for the chosen institutions, the drive for innovative solutions could be diminished.

If a rational and equitable method could be developed for transitioning to such a system of a few "chosen-best" competitors (whether they be GOCO or not), it might prove to be an efficient means for trimming existing industry overcapacity, without mortally harming future airframe development and production. In my estimation, however, there is no rational and equitable method for making such a selection, and with the real danger of crippling future advanced airframe manufacturing by making poor selections, another policy option for weapons development and production should be pursued.

Government Chooses and Exclusively Supports the Few "Best" Contractors to Survive--Graded by the Reconstitution Criteria:

1) Present military capacity vs. future military potential:
If the "best" contractors are preserved, present military operating capacity should not be diminished. Future military potential might even be enhanced by having a stronger core of tactical aircraft manufacturers. Poor choices, however, could severely diminish the future quality of aircraft.

2) Probable design diversity
Assuming the government would select three or four of the "best" contractors to survive, future diversity of designs could be preserved. The quality of these designs could potentially be diminished, however, if guaranteed profit streams to the contractors reduce their incentive to innovate.

3) Impact on prime and sub contractors

The "best" primes would have their survival guaranteed by the government. The losers would have to leave the business. The subcontractor base would likely shrink (as it would in any of the scenarios).

4) Industry responsiveness for reconstitution

Could be preserved if the three or four "winning" contractors receive adequate government support.

5) Cost

It is not clear to me how this method would reduce costs, but it would at least channel resources to fewer contractors. Guaranteeing profit streams to these surviving contractors also seems likely to destroy future price competition.

6) Probable political support

Judging by the difficulty politicians have with closing military bases, few of them would probably be in favor of politically choosing which contractors are to survive.

7) Alterations necessary to procurement bureaucracy

Minimal, except for fewer initial contracts because of the fewer existing contractors.

5.30 New Emphasis on Prototyping (with Occasional Limited Production) over the Historical Massive Procurement

It seems that all of the defense strategists and panels that have studied the future of the defense industrial base in the past couple of years have been reaching the same conclusion--with the diminishing threat of a Third World War and the corresponding shrinkage of American defense budgets, the American military must completely reorient its focus to emphasize research and prototyping. A study done in the Summer of 1990 by the Defense Science Board, a panel which reports directly to the Secretary of Defense, stated, "In the future, it should be normal practice for DoD to support exploration of weapon concepts, up to and including the early stages of development and prototype testing, that have no immediate prospect of deployment."[59] The OTA, in its July 1991 report *Redesigning Defense*, concluded that while presently R&D was almost always followed by production, in the future, the emphasis should be on "prototyping, with several development cycles between production runs."[60]

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59 Defense Science Board, p. 19.
60 Bond, AW&ST, p. 65.

Representative Les Aspin, chairman of the House Armed Services Committee, has been promoting such a transition to prototyping for years now, stating that such a program would have a threefold benefit. First, "it would preserve design and engineering expertise and continuity;" second, "it would keep us at the forefront of technology development;" and third, "it would do each of these things without the current attendant costs of a full-up production program."[61] The Pentagon seems to be starting to heed this advice because in its 1993 budget submission, it ". . . is proposing to freeze most future defense programs after the research and engineering stage, avoiding production of many weapons."[62]

This proposal is a radical departure from past Pentagon plans. In previous downcycles in defense expenditures the Pentagon seemed to view research and development as part of "the pipeline" of weapon system development, and it would cut R&D in proportion to the overall cut in the budget. In the eyes of both the public and the Pentagon insiders, a common perception has been that the value of R&D accrues only if and when fully deployed systems materialize.[63] Now, however, ". . . rather than follow the traditional route of putting [new] weapons quickly into production, in all but a few cases the Pentagon would direct the contractor to leave the blueprints on the drawing board, or the prototype on the test range.[64] In theory, at least, the weapons could then be produced on short notice if circumstances warranted.

5.31 Some of the Downsides of Such A Plan

This Pentagon plan does bring to mind some immediate concerns. As the study *Lifeline Adrift* points out, "In the absence of production, unfortunately, the supporting supply chain and the manufacturing base would wither away. Isolated R&D tends to lose touch with the real world. . . . Furthermore, the best scientific and engineering talent will not be assigned to develop R&D for the shelf."[65] The study goes on to point out that leading-edge

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61 Aspin speech on "Tomorrow's Defense," 12 Feb 1992, p. 6.
62 Healy, Boston Globe, p. 1.
63 Wagner and Gold, Science and International Security, p. 55.
64 Healy, Boston Globe, p. 14.
65 Lifeline Adrift, p. 20.

technology matures by evolution, taking time and use to work the bugs out of systems. "It is naive to expect this maturation to occur in labs and on test benches," the study concludes.

Industry is especially worried that such a plan will further starve it of funds. As a senior defense industry official noted, "Research and development clearly is something we want to see continued at a high level. . . [but] if they're going to back off the production line, where historically the industry has made money, that would be a concern."[66] Presently, industry invests much of its own funds in competitive prototyping, in hopes of winning the production contract and recouping its investment. By stripping industry of this potential for a "production reward," defense R&D will be devastated unless the Congress and the DoD find a way to reward industry for quality R&D and prototyping which does not lead to production.

Low-scale production, in itself, brings with it a number of problems. For instance, even in peace the military cannot continue to operate its older systems indefinitely--over time, systems wear out or are destroyed in training. If the systems will have to be replaced eventually, it seems indisputable that it would be more economical to replace them through mass production than through the periodic retooling of a plant and rehiring of production workers to produce low numbers of the new weapons system.

In addition to saving money, the proponents of this prototyping proposal assert that it should improve the ability of the U.S. military to reconstitute a technologically superior force more quickly than any potential adversary. If the United States felt threatened enough to initiate reconstituting its forces, however, one must question whether it would be more likely to rush its newest, unproven high-technology prototype, or its older, yet proven weapon system into production.

5.32 Answering these Concerns

The Defense Science Board report directly addresses some of the concerns of industry, stating that "To make [this] program

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66 Healy, Boston Globe, p. 14.

successful, DoD will need to treat the products of this program (e.g. successive generations of prototypes or small pilot production runs) as products in their own right, and reward industry for participating in the development of new systems even when development is not followed by large-scale production)."[67] It also seems apparent that to keep the most talented engineers working on weapons system prototyping, the new prototyping paradigm would have to be crafted such that there would still be competition to determine which prototypes went into the low-scale production. If industry were rewarded simply for building prototypes, without some connection being made to such things as cost, manufacturability, reliability, and maintainability, there would be no incentive for industry to keep its most skilled engineers working on these prototypes.

The criticism about the dangers of "isolated R&D" is valid, but the new paradigm can easily get around this. In Rep. Aspin's plan, prototypes would be "production-representative" and would undergo thorough testing in "an operational context."[68] If the prototypes were to be developed as "science projects," their technologies could easily become esoteric and the prototypes themselves no more than super-expensive toys for scientists. Prototypes should therefore be tested and evaluated by military test pilots, and evaluated not on "gee-whiz" aeronautical gimmickry, but upon specific warfighting criteria. The Grumman X-29, an agile, supersonic aircraft with forward-swept wings, did a great deal to advance engineers' knowledge of how an advanced-composite aircraft was built and how an aircraft handled at super-high angles of attack, but it would be not be an effective combat fighter.

Future prototypes developed under the new weapon-development proposal should be evaluated to ensure that they meet some minimum requirements (in terms of handling qualities, range, stealth, weapons-carrying capacity, etc.), and then sent on to ranges where they can be graded on weapons-deployment capabilities, and (for the

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67 Defense Science Board, p. 21.
68 Aspin, speech on "Tomorrow's Defense," p. 6.

ones that make it this far) on to warfighting simulations. Thus, a typical tactical aircraft prototype for the Air Force would first go to Edwards to ensure its flying qualities were acceptable, then on to a weapons range such as China Lake or Eglin, and finally into warfighting simulations such as Red Flag (for fighter aircraft) and Ft. Irwin (for attack aircraft). Only in such a manner can the nation be ensured that the prototypes were being designed for their warfighting capacity, and only in such a manner could the nation be assured that the bugs were worked out of the system to such an extent that if the nation did decide to reconstitute, it could be confident of the prototype aircraft's capacity to perform.[69]

Testing in such a manner might cause one to question how much money would actually be saved. Upgrades to existing systems would have to be taking place concurrently to keep the older weapons systems technologically superior to those that the Third World nations are acquiring. Low-rate production can be expensive. But still, money should be saved by this system. Instead of replacing the entire fleet of F-15's with 650 ATF's over the next 30 years at a cost of 100 billion dollars as is presently planned, in the same time period but at a lower cost, 150 ATF's could be built, some F-15's could be upgraded, and two or three new generations of prototype aircraft could be initiated (some of which would even be likely to go into low-level production). This would maintain America's present superiority in the short run, give the U.S. a fleet of stealthy, next-generation ATF's for the "middle run" (to serve as force-multiplying "silver bullets" like the stealth fighters in the Gulf War), and perhaps provide two new generations of silver-bullets in the longer run. At the end of thirty years, the U.S. military will have in operation attack and fighter aircraft two generations ahead of what it would have had under the present paradigm; it will at all times have the capacity to rush into production a next-generation tactical aircraft; and it should be able to get all of this for less money than it would have spent procuring 650 ATF's.

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69 See Appendix B for proposed weapons development flowcharts.

It is also worth mentioning that under such a system of weapons development, it might prove cost effective to at last optimize tactical aircraft for a specific mission, rather than optimize them for a range of missions with dramatically different requirements as is presently the case. For example, over 2,000 F-16's have been produced, and this aircraft is used for missions as disparate as counterair and ground attack, tactical reconnaissance and SAM supression. If, instead, distinct aircraft were designed and prototyped for each of these types of missions (and then 50 to 100 of them were procured for each mission), a smaller force size might prove to be dramatically more effective, even without revolutionary technological breakthroughs.

If all of this sounds too good to be true, that is because there is one catch--for this proposal to save significant amounts of money, a far greater number of aircraft will have to be retired than are replaced. But this is a reasonable assumption, considering that the present "minimum" of 26 tactical aircraft wings seems likely to be reduced further (assuming the present reduction in world tension persists), and that the next-generation aircraft which will be coming along to replace the retiring fleet will be force-multiplying silver bullets (given that one such system can do the job of two-or-more present-generation systems). It seems, then, with this smaller force of "silver bullets" reinforced with upgrades to older systems, that money could be saved concurrent with the technological advancement this paradigm would entail.

The dilemmas of laying off a skilled workforce and diminishing the subcontractor supplier base remain. Unfortunately, these problems are common to all of the potential weapons-development plans, from the absolute "hands-off" policy to the complete government takeover of the industry--in the current international environment, the downsizing of the defense industry is inevitable. Skilled workers will still be necessary to put together the prototypes, however, and the real experts may become more itinerant in the future, shifting to different companies as the different firms win low-scale production contracts. Others may find jobs

working on upgrades such as the life-extending re-winging of some of America's older aircraft which will have to take place. The others will simply have to find jobs in other sectors.

The story for the subcontractors is similar. The most successful ones will find commercial users for their products and still supply their parts to the low-rate production aircraft. Others will work on upgrades. Inevitably, however, in the shrinking defense industry, some skilled workers will lose their jobs and some defense subcontractors will go out of business. But this prototyping with limited production (plus upgrades) plan will probably do more to mitigate damage than either the Darwinian hands-off or the Leviathan government-run paradigms would have done.

5.33 Other Advantages to the Prototyping Paradigm

As the Carnegie Commission found in its recent report *New Thinking and American Defense Technology*, "Prototyping not only speeds new technology into fielded systems; even more importantly, it allows decisions on full scale development to be based on cost, performance and development schedule."[70] The DoD adopted such a "fly-before-buy" policy that emphasized testing prototype systems before production all the way back in 1969 under Former Deputy Secretary of Defense David Packard. This policy was reversed in 1977 following a Defense Science Board finding that the development and production of weapons were taking too long, and then re-adopted in 1986.[71] If it made sense to follow this "fly-before-buy" policy under the old, massive procurement paradigm while the U.S. was facing a daunting threat, it makes even more sense to do so now. With no pressing threat, there is time to correct any problems with the prototyped systems before they go into production (if they do so at all).

Some die-hard cold warriors are still pointing to a potential revival of the former Soviet Union as a justification for the US to maintain its massive procurement paradigm. The former Soviets, however, have opted to continue the production of only one of their

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70 Carnegie Commission, p. 22.
71 Behler, Defense Acquisition in the Post-Cold War Era, p. 24.

top-line fighters (the Su-27) for domestic use in order to devote the rest of their resources to the development of next-generation aircraft. The Su-27 is at least a generation behind the ATF. Therefore, it makes sense for the U.S. to create a small, "silver-bullet" force of ATF's, while devoting most of its resources to its own development of an even newer generation of tactical aircraft.

Some fear that this could lead to a "virtual" arms race, in which the two nations compete to design and create small forces of high-technology weaponry. But ". . . better a virtual arms race than a real one," Wagner and Gold state.[72] And besides, a competition of engineering designs is a competition the U.S. is bound to win.

The Institute for Defense & Disarmament favors this limited procurement plan for another reason. Because this group is concerned about the proliferation of high-technology aircraft to the Third World, as they see it, this type of limited production scheme should also serve to limit proliferation.

The last significant factor which weighs in favor of this proposal for arms-development is that it is gathering political momentum. As was mentioned, the Pentagon proposed a variation of this plan for its 1993 budget. Individuals as far apart in their views on defense as Secretary of Defense Richard Cheney and Senator Edward Kennedy both presently support development over production of new weapons systems. Said Cheney, "the 1990's should be the decade of development more than production."[73] The *Boston Globe* added, "Senator Kennedy and others want a cutback on the rapid production of new weapons, while funding research and upgrading existing systems until next generation systems can be produced."[74] Congress-persons from regions with large workforces employed by the defense industry have vowed to fight this type of plan, however.

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72 Wagner and Gold, Science and International Security, p. 65.
73 Lancaster, Washington Post, p. A12.
74 Putzel, p. 14.

Grading Continuous Prototyping with Periodic Limited Production by the Reconstitution Criteria

1) Present military capacity vs. future military potential:

With present systems being upgraded and a small, silver-bullet force of next-generation aircraft being produced, short and medium-range operating capacity would be enhanced. Long-range military potential would also be enhanced assuming even more-advanced aircraft are developed and politicians have the will to put them into low-level production.

2) Probable design diversity

It would be great, as engineering design teams remain together and compete for contracts to build high-quality, next-generation prototypes in the hope of eventually winning a contract to put their prototype into limited production.

3) Impact on prime and sub contractors

Primes would have to be reoriented to reward quality prototyping, even when it does not reach production. Primes could also compete for business by trying to develop the most cost-effective upgrades for existing airframes. As for subcontractors, many would have to reorient to focus upon upgrades. A few could probably maintain their focus on new systems, while some would have to diversify to the commercial world to remain in business.

4) Industry responsiveness for reconstitution

While there would be "down times" in which no fighter was in production, there should almost always be some next-generation, well-tested prototype which could be put into production. Also, because air-to-air fighters and air-to-ground attack aircraft require different designs, it seems likely that one would remain in production while the other was in-between production stages.

5) Cost

The OTA study found that with increasing budget constraints, the emphasis of weapons development should be on the future over the present as long as a large threat remains remote.[75] Efficient production of small numbers of "silver- bullet" systems which serve as force multipliers, should be less costly than the massive procurement of less advanced systems.

6) Probable political support

The plan seems to have enough support from both parties and both ideologies to pass, but expect a battle in the short run.

7) Alterations necessary to procurement bureaucracy

Military promotions for procurement officers should be based on something other than successfully moving a weapons system from development to production. The military must devote more of its budget to R&D (to include prototyping) than to production. More emphasis must also be placed upon testing before production.

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75 Bond, AW&ST, p. 65.

6.0 CONCLUSION AND RECOMMENDATIONS

History has shown that a nation is better able to keep aggression and adventurism at bay through the maintenance of a credible military deterrent. A highly trained base-force armed with superior weaponry may be able to provide America with such a deterrent in the short run. To deter hostile actions over the longer run, however, the U.S. needs the ability to reconstitute a technologically superior force more rapidly than any potential adversary.

Unfortunately, America's continued reliance upon cold war procurement policies will, in this era of eased international tensions and declining defense budgets, soon compel its technologically-dependent base forces to rely upon dangerously antiquated systems. Potentially even more dangerous, the U.S. defense industry, which will have to form the basis for any future rapid reconstitution, is already withering away as the number of defense contracts plummets.

This policy analysis explored variations of three potential governmental policies for ensuring a future of continued high-technology weaponry and a responsive defense base. Option 1, the present hands-off management of the defense industry decline, was not found to be in the nation's long-term interest. This was because teaming is inhibiting the economic restructuring of the industry, and it is likely to leave a weakened aerospace defense base. The other hands-off policies were found to be similarly limited in their capacity to preserve the defense industry. Commercial diversification, for instance, has rarely been successful for defense contractors, and is a wasteful diversion for some of the firms. Exports help defense firms at a cost many find unacceptable--the proliferation of high-technology weaponry. There is a limit to how much stealth can be added on to upgrades.

Option 2, the more direct government control of weapon development and production, was also not found to be in the nation's best interest. While not usually recognized as such, a government/industry consortium of shared responsibility in weapons

development and production already exists. Nationalizing the tactical airframe industry and running it with civil servants hired from the old independent companies would break up the critical design teams and probably further separate defense from commercial technologies. Neither hawks nor doves in Congress would be likely to tolerate such a radical government takeover, anyhow. If the government were able to select the few "best" contractors to support, such a plan might be an effective way to reduce overcapacity without crippling the future airframe industry. The guaranteed profit stream could, however, reduce competitive pressures to innovate. A more immediate (and seemingly insurmountable) barrier to such a plan is finding a rational, measurable means for determining the "best" contractors.

Prototyping with limited procurement, then, seems to be the optimal policy. It preserves the level of high-technology weaponry while sustaining a viable industrial base for a potential reconstitution. This plan also has in its favor that it is gaining momentum with policymakers in Washington. For this option to really be in the nation's best interest, however, three additional qualifications which are absent from the debate in Washington must be delineated.

First, should this plan become the new paradigm for weapons development and production, additional funding and emphasis must be placed upon the evaluation of prototypes for their warfighting potential, not just their aerodynamic performance and handling qualities. Systems which have not proven their military utility will be of little value should the need for a rapid reconstitution arise. The type of testing which the Air Force does out at Edwards Air Force Base, for example, in which such qualities as a prototype's handling characteristics and range are evaluated, is dangerously inadequate. A commitment must also be made to evaluating the prototype's performance in munitions deployments and warfighting simulations to ensure that the systems perform as promised under fire. This type of intensive testing should also be a good measure of such critical qualities as the maintainability and reliability of an aircraft.

Concurrent with accepting this new paradigm for weapons development and production, the nation must also make a commitment to building a military of force-multiplying "silver bullets" a cornerstone of this plan. Should Congress be taken by the money savings of exclusively prototyping (without ever putting the prototypes into limited production), industry will lose its incentive to design and its capacity to produce, and both the short and long-run warfighting potential of the military will be dangerously eroded.

Finally, to ease the transitions of both the defense industry and the military from their historical reliances upon massive procurement to this new paradigm of ongoing prototyping with occasional limited production, upgrades to existing systems should be emphasized until new systems which provide significantly enhanced performance are developed.

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Appendix A: SKUNK WORKS--PANACEA OR PLACEBO?

People for and against the prototyping paradigm often point to Lockheed's Advanced Development Company, or "Skunk Works" as the model for the future defense base. Those against the prototyping plan proclaim that it is not the procurement system which needs to be restructured as much as it is the defense industry; they feel that weapons development would best be enhanced not by radically altering Pentagon policy, but by radically trimming defense-firms' largesse into skunk-works' efficiency. Others who favor the prototyping plan, including Representative Les Aspin, point to Lockheed's Skunk Works as evidence that ongoing prototyping and limited production ". . . can be achieved, and that it can indeed be profitable."[76]

Both proponents and opponents of the prototyping paradigm often point to Lockheed's success with skunk work techniques in developing such advanced aircraft as the P-38, F-104, U-2, SR-71, and F-117. Both would probably also agree that this type of development enables high-technology aircraft to be developed and produced in a short period of time and in small quantities, yet at a reasonable profit. From either perspective, these are clearly desirable goals. Some additional perceived benefits are that skunk work development projects require fewer auditors, lesser government oversight, and even fewer engineers.

In praising skunk work results, however, a few common characteristics are often neglected. First, these development projects are always black, with oversight reduced to an absolute minimum. Second, every skunk work project ever undertaken has been for a system which the nation wanted to urgently deploy. These two imperatives allow skunk work projects to bypass the established

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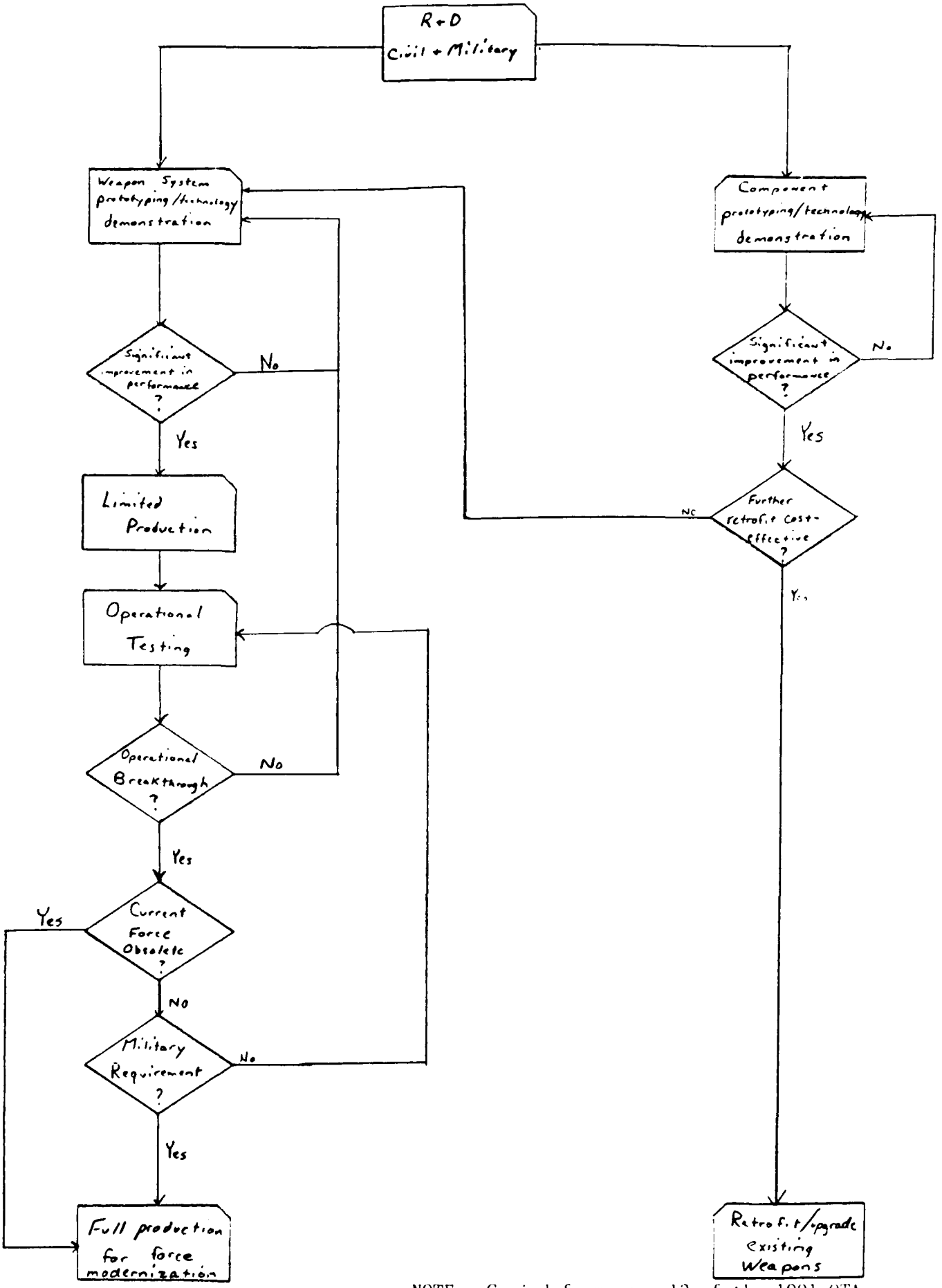
76 Aspin, Report on "Tomorrow's Defense," pg. 19.

acquisition process of endless reviews--probably the primary factor in reducing the development time for skunk work aircraft.

In the future, however, it is doubtful that Congressmen are going to support more black development projects since they do, in essence, hide public expenditures from public inspection. With the reduced military threat, it is also doubtful that in the near future any system will be considered urgent. Less government oversight can mean less constructive feedback when there is time built into the process for tests and modifications. The fact that such a system requires fewer engineers is also not necessarily a benefit if one considers it desirable for reconstitution to keep a large cadre of experienced weapon designers.

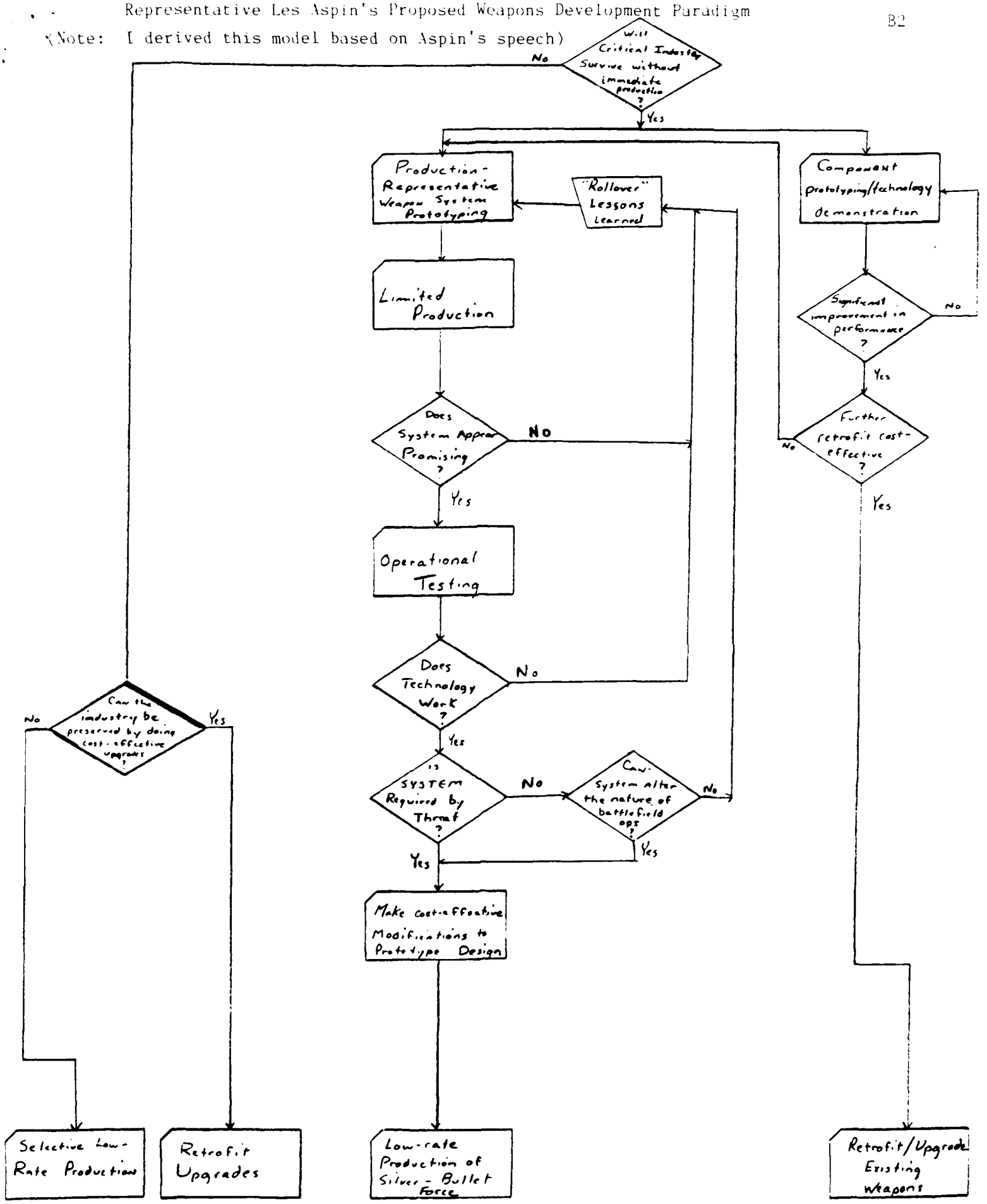
There is no debating the success of Lockheed's Skunk Works in rapidly developing high-technology weapons systems and in producing them profitably in small numbers. There is, however, room for debate as to whether the success of Skunk Works can be generalized, or if its success stems simply from the fact that it is a unique process for evading the Pentagon bureaucracy. Probably, there is some truth to both. Considering the likely future trends toward more openness and less urgency in weapons developments (both of which are inconsistent with skunk work projects), however, skunk works do not seem to be a magic panacea for preserving a high-technology, responsive defense base.



NOTE: Copied from page 12 of the 1991 OTA report entitled "Redesigning Defense"

Representative Les Aspin's Proposed Weapons Development Paradigm

(Note: I derived this model based on Aspin's speech)

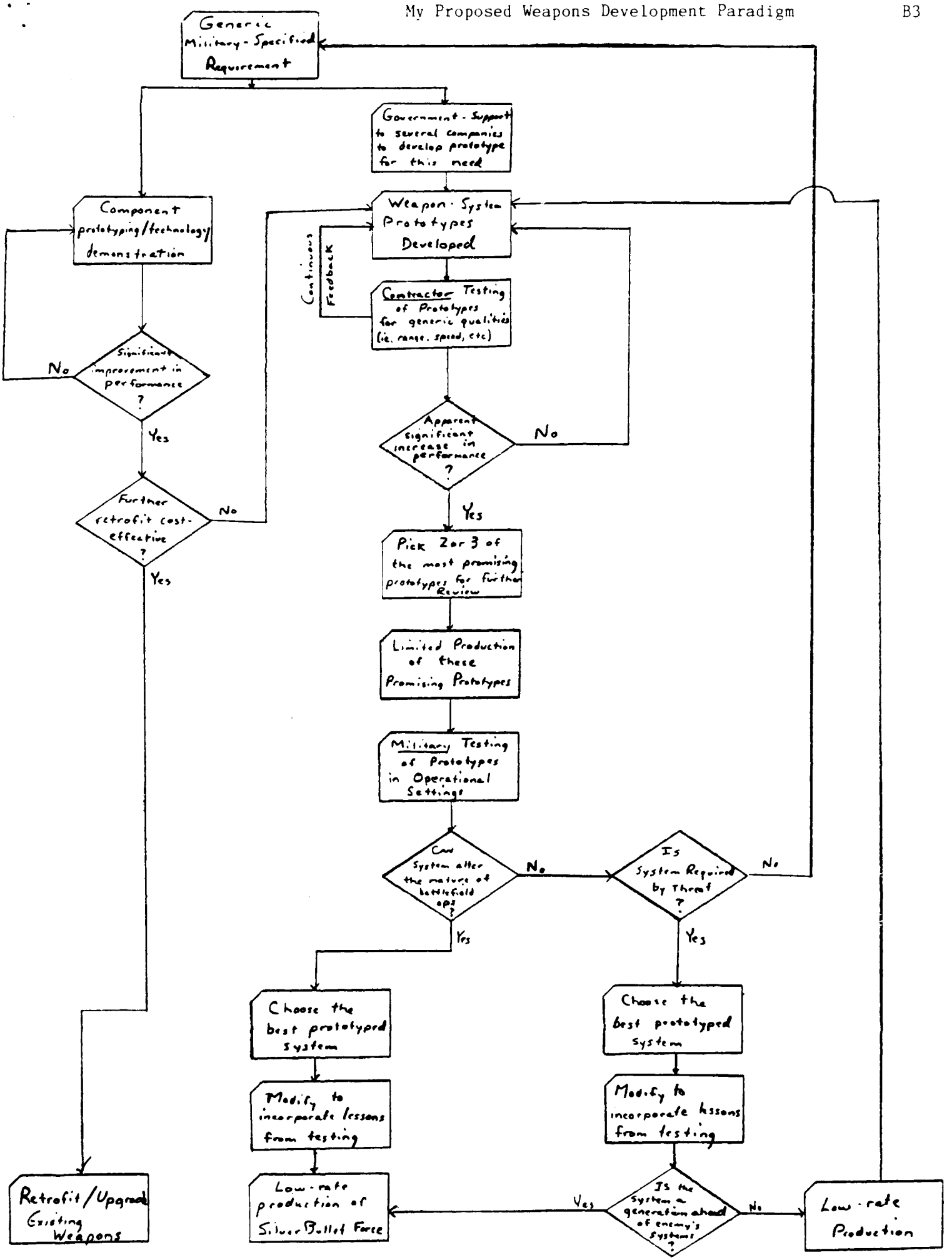


Example: NAVAL Nuclear Reactors

Example: Early Abrams tanks upgraded to M1A2 versions

Example: Future Attack and Fighter aircraft

Example: Perhaps a future stealth upgrade to the F-16


Generic Military-Specified Requirement
Government-Support to several companies to develop prototype for this need
Component prototyping/technology demonstration
Weapon-System Prototypes Developed
Continuous Feedback
Contractor Testing of Prototypes for generic qualities (ie. range, speed, etc)
Significant improvement in performance ?
No
Yes
Apparent significant increase in performance ?
No
Yes
Further retrofit cost-effective ?
No
Yes
Pick 2 or 3 of the most promising prototypes for further Review
Limited Production of these Promising Prototypes
Military Testing of Prototypes in Operational Settings
Can System alter the nature of battlefield ops ?
No
Yes
Is System Required by Threat ?
No
Yes
Choose the best prototyped system
Choose the best prototyped System
Modify to incorporate lessons from testing
Modify to incorporate lessons from testing
Retrofit/Upgrade Existing Weapons
Low-rate production of Silver Bullet Force
Is the system a generation ahead of enemy's systems ?
Yes
No
Low-rate Production

COMMENTS AND CRITICISMS OF THE PROPOSED WEAPONS DEVELOPMENT PARADIGMS

OTA MODEL (see Appendix B1):

The OTA significantly enhanced the debate on future weapons-development paradigms by drawing a flowchart of their proposal. With this method, entire proposals can be contained on one sheet of paper, making it much easier to compare and contrast the relative merits of different plans.

As for the model itself, the OTA proposal for analyzing upgrades was identically incorporated into the latter two weapons-development proposals, which is some indication of its merits. The idea of concurrently developing components for upgrades and entirely new weapon systems was also mirrored by the latter proposals.

The OTA model does have some questionable features as well, however. First of all, it does not seem logical that the last question to be asked before a decision to undergo "full force modernization" should be: "Is the system a military requirement? It seems much more sensible for this question to be asked at the outset, because if there is not a perceived military requirement for such a system then resources should be devoted elsewhere. It also is not entirely clear to me why, if the system is not a military requirement, it should revert to operational testing and not be scrapped entirely.

Another limitation of this model is that for a system to go into full production it must be both an operational breakthrough and the current force must be obsolete. Aspin's model seemed to offer an improvement over this by having either be grounds for production. Even if the existing force is not obsolete, it is not clear why the nation should inhibit the production of a new system if it is a truly a breakthrough in operations, or as Aspin calls it, a breakthrough which can alter the nature of battlefield

operations. The F-117, for instance, might never have been produced if the OTA guidelines were closely adhered to.

Representative Les Aspin's Model (see Appendix B2):

The first improvement in Aspin's model over the OTA model was already noted. In Aspin's view, a system should go into low-rate production if it is either required by a threat or if it is a breakthrough in battlefield operations. He also adds provisions for continuing the production of certain key defense systems if it becomes apparent that a critical industry will not survive without immediate production contracts of some sort. In addition, Representative Aspin makes it quite clear that the lessons learned from the developing and testing of these prototypes (whether they be successes or failures) must be "rolled over" into future weapons system developments.

One apparent flaw of Aspin's approach is that in his desire to have enough production-representative prototypes produced for effective operational testing, he asks the question, "Does the system appear promising?" after he produces the limited force of testable prototypes. It seems to me this question should be asked before the limited force of production-representative prototypes are procured.

My Proposed Weapons Development Model (see Appendix B3):

Incorporating the contributions of the OTA and Aspin models, I add a few more stages which I think would further enhance the weapons-development process. First, I start the model with a government-specified, generic military requirement which the government would like to see met with some technological advancement. If the government does not perceive a need for a new capability, it does not seem sensible for it to fund the research for such an advancement. This seems so obvious that it should be

implicit, but since the OTA model asked this question (of military necessity) last, I wanted to show that it should be asked first.

I also explicitly added the idea of competition in prototyping. This is what is going to keep the design end of the weapons development business intact and advanced, so I did not want it to be overlooked.

Next, I added that for generic qualities (such as range, endurance, maximum airspeeds, etc.), the contractors should test their prototypes themselves. This is in accordance with the ninth of Kelly Johnson's "Skunk Works Rules," which stated: "Contractors must be delegated the authority to test their products. They can and must test them in the initial stages. If they do not, they rapidly lose their competency to design other vehicles."[77] In addition, there is really no reason for the government to get involved in the flight testing of such basic qualities.

If it becomes apparent that some of the prototypes from this process would offer a significant increase in performance over existing alternatives, the government should then choose the 2 or 3 most promising prototypes and produce a limited number of them as "production representative" models for operational testing. This operational testing should be done by the military, since they will be the operational users.

The final improvement I would offer the Aspin model would be differentiating between the types of production based upon whether a system is a breakthrough or whether a system is simply a requirement to meet a threat. If a system is not a breakthrough and/or it is not at least a generation ahead of a potential enemy's system (but it is still required to meet a threat), then producing a limited "silver-bullet force" will not be effective. Instead, this type of system should be put into low-rate production in a short-run attempt to plug the gap posed by the potential enemy's

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77 Behler, Defense Acquisition in the Post-Cold War Era, pg. 78.

superior system, while continuing emphasis should be placed upon the development of a more advanced follow-on system.

Conclusion:

I suspect my proposal is not the end-all model for weapons development either, but just as the Aspin model seemed an improvement over the earlier OTA model, I hope my model seems an improvement over the Aspin model. I would welcome suggestions as to how to improve my proposal.